

NHDOT SPR2 PROGRAM
RESEARCH PROGRESS REPORT

Project # SPR 26962U		Report Period Year 2021 <input type="checkbox"/> Q1 (Jan-Mar) <input checked="" type="checkbox"/> Q2 (Apr-Jun) <input type="checkbox"/> Q3 (Jul-Sep) <input type="checkbox"/> Q4 (Oct-Dec)	
Project Title: Improved Practices for Determining the Infiltration Characteristics of Soils for Design of Stormwater BMPs			
Project Investigator: Jean Benoit, PhD Phone:		E-mail: jean.benoit@unh.edu	
Project Start Date: April 17, 2019	Project End Date: March 31, 2022, extended	Project schedule status: <input checked="" type="checkbox"/> On schedule <input type="checkbox"/> Ahead of schedule <input type="checkbox"/> Behind schedule	

Brief Project Description:

Soil infiltration data are utilized by the NH Department of Transportation (NHDOT) to assess the suitability of a site for various stormwater best management practices (BMPs) and to properly size and design a treatment area. With the recent issuance of EPA's final Municipal Separate Storm Sewer System (MS4) permit rules, the need for such testing is expected to increase.

In order to estimate infiltration rates, the NHDOT currently utilizes a variation of the borehole infiltration test prescribed in the NH Department of Environmental Services (NHDES) Alteration of Terrain (AoT) rules using conventional geotechnical drilling equipment. Existing testing protocols are labor intensive and time consuming, often taking 4 hours or more to complete a single test interval (depth). This is particularly inefficient if multiple depths require testing, e.g. if the preferred "bottom of practice" has not been established. In addition, the existing test method may not replicate field conditions and is prone to missing important features in the soil profile. Other available tests either require a constant head that is difficult to maintain in the field or have limitations associated with the effective depth of the test or the level of the groundwater table. Research is needed to evaluate alternative methods and improve Department practices to allow for more effective design of BMPs.

A permeafor device, originally developed in France, has been identified as a potential alternative to current practice. The permeafor is an in-situ hydraulic profiling tool that provides a quick estimate of the permeability profile of soil layers and can be adapted to conventional drilling equipment.

The objectives of this research are as follows:

1. Review available permeafor drawings, adapt design features to be compatible with NHDOT equipment and operations, and fabricate a prototype for further evaluation in the field.
2. Compare the performance of the permeafor alongside existing test method.
3. Recommend and implement design modifications as a result of initial testing.
4. Provide a workable permeafor device suitable for implementation on NHDOT projects.

The scope of work for this research includes the following major tasks, with primary responsibility indicated in parentheses:

1. Obtain available permeafor plans, shop drawings, and details. (UNH)
2. Recommend design changes to ensure compatibility with geotechnical drilling equipment operated by the NHDOT. (UNH/NHDOT)
3. Fabricate one or more permeafor devices. A total of two (2) devices are anticipated as part of the research. It is suggested that a single device be fabricated for initial testing and the second device be fabricated to incorporate lessons learned after the initial testing. (UNH)
4. Procure required pumps, flowmeters, and other ancillary equipment. (UNH)
5. Calibrate the permeafor with grain-size analyses and permeability water tests performed in the laboratory. (UNH)
6. Identify field sites for testing. A minimum of three (3) sites will be evaluated, with multiple depths tested at each site. Sites will be chosen where NHDOT-obtained infiltration data has been collected or will be collected during the research. (UNH/NHDOT)

NHDOT SPR2 PROGRAM

RESEARCH PROGRESS REPORT

7. Conduct initial field testing at one or two sites. (UNH/NHDOT)
8. Review existing formula(s) used to convert field data to the Design Infiltration Rate needed for BMP design. (UNH)
9. Conduct final field testing at remaining sites. (UNH/NHDOT)
10. Recommend modifications to formula(s) used to convert field data to the Design Infiltration Rate needed for BMP design. (UNH)
11. Provide a final report summarizing the research and containing recommendations for implementation by NHDOT. (UNH)

Progress this Quarter (include meetings, installations, equipment purchases, significant progress, etc.):

During this past quarter, the investigation of water flow during permeafor testing into a granular soil formation was completed using finite element analysis with the Plaxis 2D software. The results from this study support the assumptions made for flow surrounding the permeafor during testing. Additional field tests were conducted in Merrimack, NH, along the FE-Everett Turnpike to record a training video of the permeafor testing procedure and to continue comparisons with borehole infiltration test results. Fabrication on the second permeafor probe is ongoing. The graduate student associated with this project, Alex Lefebvre, graduated at the beginning of June and presented his findings during his thesis defense.

Items needed from NHDOT (i.e., Concurrence, Sub-contract, Assignments, Samples, Testing, etc...):

No further testing is required for this project. However, it is recommended that testing takes place at another site with NHDOT personnel operating the permeafor under our guidance. This would allow us to modify the user's manual and data acquisition system as needed and suggested by NHDOT personnel.

Anticipated research next three(3) months:

The permeafor field testing control and acquisition software will continue to be updated to help simplify and standardize the testing procedures. The LabVIEW user interface is being recoded to automate the control and acquisition system during driving of the permeafor as well as during permeafor testing. The system is being configured to be more user-friendly and less operator sensitive. Construction of an updated second permeafor probe will also be completed. We also anticipate ordering other ancillary support equipment such as a flow pump and flowmeter. Include permeafor testing into the NHDOT Geotechnical Manual, as appropriate. Compile results from Wuebbolt and Lefebvre and publish our findings in peer-reviewed publications.

Circumstances affecting project:

Availability of NHDOT drilling equipment and personnel have been difficult during this Covid pandemic and with staff shortage. Nevertheless, we managed to complete our testing to meet the contract requirements.

Tasks (from Work Plan)	Planned % Complete	Actual % Complete
<i>Task 1: Permeafor plans</i>	100	100
<i>Task 2: Permeafor – drill rig compatibility</i>	100	100
<i>Task 3: Permeafor probes construction</i>	100	75
<i>Task 4: Ancillary equipment purchases and assembly</i>	50	50
<i>Task 5: Permeability tests in laboratory</i>	90	90
<i>Task 6: Site selection</i>	100	100
<i>Task 7: Conduct initial testing</i>	100	100
<i>Task 8: Review of existing formulas for analysis</i>	90	90
<i>Task 9: Conduct final testing</i>	100	100
<i>Task 10: Recommendations</i>	80	80
<i>Task 11: Final report</i>	80	80

Barriers or constraints to implementing research results

None